Structure fire cause methodology

Since the introduction of NFIRS 5.0, the implementation of the cause hierarchy has resulted in a steady increase in the percentages of unknown fire causes. This increase may be due, in part, to the fact that the original cause hierarchy (described in "Fire in the United States 1995-2004," 14th edition) does not apply as well to NFIRS 5.0. Causal information collected as part of NFIRS 5.0 was not incorporated in the old hierarchy. As a result, many incidents were assigned to the unknown cause category. As the hierarchy was originally designed for structures, incidents that did not fit well into the structure cause categories were also assigned to the unknown category.

Structure fires

To capture the wealth of data available in NFIRS 5.0, the USFA developed a modified version of the previous cause hierarchy for structure fires as shown in Table 1. The revised schema provides three levels of cause descriptions: a set of more detailed causes (priority cause description), a set of midlevel causes (cause description), and a set of high-level causes (general cause description). The priority cause description and the cause description existed previously as part of the original cause hierarchy but have been expanded to capture the 5.0 data.

Table 1. Three-level structure fire cause hierarchy

Priority cause description (in hierarchical order)	Cause description	General cause description
Exposure	Exposure	Exposure
Intentional	Intentional	Firesetting
Cause under investigation	Cause under investigation	Unknown
Children playing	Playing with heat source	Firesetting
Other playing		
Natural	Natural	Natural
Fireworks	Other heat	Flame, heat
Explosives		
Smoking	Smoking	
Heating	Heating	Equipment
Cooking	Cooking	
Air conditioning	Appliances	
Electrical distribution	Electrical malfunction	Electrical
Appliances	Appliances	Equipment
Special equipment	Other equipment	
Processing equipment		
Torches	Open flame	Flame, heat
Service equipment	Other equipment	Equipment
Vehicle, engine		
Unclassified fuel-powered equipment		
Unclassified equipment with other or unknown fuel source	Unknown	Unknown
Unclassified electrical malfunction	Electrical malfunction	Electrical
Matches, candles	Open flame	Flame, heat
Open fire		
Other open flame, spark	Other heat	
Friction, hot material		
Ember, rekindle	Open flame	
Other hot object	Other heat	
Natural condition, other	Natural	Natural
Heat source or product misuse	Other unintentional, careless	Unknown
Equipment operation deficiency	Equipment misoperation, failure	Equipment
Equipment failure, malfunction		
Trash, rubbish	Unknown	Unknown
Other unintentional	Other unintentional, careless	
Exposure (fire spread, other)	Exposure	Exposure
Unknown	Unknown	Unknown

Source: USFA.

Note: Fires are assigned to a cause category in the hierarchical order shown. For example, if the fire is judged to be intentionally set and a match was used to ignite it, it is classified as intentional and not open flame because intentional is higher on the list.

The causes of fires are often a complex chain of events. To make it easier to grasp the "big picture," the 16 midlevel categories of fire causes, such as heating, cooking, and playing with heat source, are used by the USFA. The alternative is to present scores of detailed cause categories or scenarios, each of which would have a relatively small percentage of fires. For example, heating includes subcategories, such as misuse of portable space heaters, wood stove chimney fires, and fires involving gas central heating systems. Experience has shown that the larger categories are useful for an initial presentation of the fire problem. A more detailed analysis can follow.

Fires are assigned to one of the 16 midlevel cause groupings using a hierarchy of definitions, approximately as shown in Table 2.[1] A fire is included in the highest category into which it fits on the list. If it does not fit the top category, then the second one is considered, and if not that one, the third, and so on. (See the note section in Table 1 for an example.)

Vehicle, outside and other fires

While these cause categories have usefulness for the other property types — vehicle, outside and other fires — there are limitations. For these property types, the causes of fires are based on the distributions of the NFIRS cause of ignition data element. This data element captures a very broad sense of the cause of the fire.

Deaths, injuries and dollar loss

In previous analyses, the cause sections have included the distributions of deaths, injuries and dollar loss by fire cause. In principle, it is the cause of the fire that results in deaths, injuries and dollar loss that should be analyzed — not numbers of deaths and injuries associated with fire causes. Therefore, analyses of fire cause address fires that result in deaths (fatal fires), fires that result in injuries, and fires that result in dollar loss.

Other considerations

An additional problem to keep in mind, when considering the rank order of causes, is that sufficient data to categorize the causes was not reported to the NFIRS for all fatal fires in the database. The rank order of causes might be different than shown here if the cause profile for the fires where causes were not reported to the NFIRS was substantially different from the profile for the fires where causes were reported. However, there is no information available to indicate that there is a major difference between the known causes and the unknown causes, so the USFA's best present estimate of fire causes is based on the distribution of the fires with known causes.

[1] The structure fire cause hierarchy and definitions can be found in the document "National Fire Incident Reporting System Version 5.0 Fire Data Analysis Guidelines and Issues," July 2011, available at *https://www.usfa.fema.gov/downloads/pdf/nfirs/nfirs_data_analysis_guidelines_issues.pdf*. The hierarchy involves a large number of subcategories that are later grouped into the 16 midlevel cause categories, then the seven high-level cause groupings.

Table 2. Midlevel cause groupings

Cause category	Definition
Exposure	Caused by heat spreading from another hostile fire.
Intentional[2]	Cause of ignition is intentional, or fire is deliberately set.
Cause under investigation	Cause is under investigation, and a valid NFIRS Arson Module is present. (This category was formerly called "Investigation with Arson Module.")
Playing with heat source	Includes all fires caused by individuals playing with any materials contained in the categories below, as well as fires where the factors contributing to ignition include playing with heat source. Children playing with fire is included in this category.
Natural	Caused by the sun's heat, spontaneous ignition, chemicals, lightning, static discharge, high winds, storms, high water including floods, earthquakes, volcanic action, and animals.
Other heat	Includes fireworks, explosives, flame/torch used for lighting, heat or spark from friction, molten material, hot material, heat from hot or smoldering objects.
Smoking	Cigarettes, cigars, pipes, and heat from undetermined smoking materials.
Heating	Includes confined chimney or flue fire, fire confined to fuel burner/boiler malfunction, central heating, fixed and portable local heating units, fireplaces and chimneys, furnaces, boilers, water heaters as source of heat.
Cooking	Includes confined cooking fires, stoves, ovens, fixed and portable warming units, deep fat fryers, open grills as source of heat.
Appliances	Includes televisions, radios, video equipment, phonographs, dryers, washing machines, dishwashers, garbage disposals, vacuum cleaners, hand tools, electric blankets, irons, hair dryers, electric razors, can openers, dehumidifiers, heat pumps, water cooling devices, air conditioners, freezers and refrigeration equipment as source of heat.
Electrical malfunction	Includes electrical distribution, wiring, transformers, meter boxes, power switching gear, outlets, cords, plugs, surge protectors, electric fences, lighting fixtures, electrical arcing as source of heat.
Other equipment	Includes special equipment (radar, X-ray, computer, telephone, transmitters, vending machine, office machine, pumps, printing press, gardening tools, agricultural equipment), processing equipment (furnace, kiln, other industrial machines), service, maintenance equipment (incinerator, elevator), separate motor or generator, vehicle in a structure, unspecified equipment.
Open flame, spark (heat from)	Includes torches, candles, matches, lighters, open fire, ember, ash, rekindled fire, backfire from internal combustion engine as source of heat.
Other unintentional, careless	Includes misuse of material or product, abandoned or discarded materials or products, heat source too close to combustibles, other unintentional (mechanical failure/ malfunction, backfire).
Equipment misoperation, failure	Includes equipment operation deficiency, equipment malfunction.
Unknown	Cause of fire undetermined or not reported.

Source: USFA.

[2] Fires caused by intentional actions include, but are not limited to, fires that are deemed to be arson. Intentional fires are those fires that are deliberately set, and they include fires that result from the deliberate misuse of a heat source and fires of an incendiary nature (arson) that require fire service intervention. For information and statistics on arson fires only, refer to the Uniform Crime Reporting Program arson statistics from the U.S. Department of Justice, FBI, Criminal Justice Information Services Division, *https://www.fbi.gov/about-us/cjis/ucr/ucr.*

NFIRS fire causal data can be analyzed in many ways, such as by the heat source, equipment involved in ignition, factors contributing to ignition, or many other groupings. The hierarchy of causes has proven to be useful in understanding the fire problem and targeting prevention, but other approaches are useful too. Because the NFIRS database stores records fire-by-fire, and not just in summary statistics, a wide variety of analyses is possible.

The cause categories displayed in the graphs of the USFA's NFIRS data-related reports are listed in the same order to make comparisons easier from one to another. The y-scale varies from figure to figure, depending on the largest percentage that is shown; the y-scale on a figure with multiple charts, however, is always the same.